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H. 知的財産権の出願・登録状況

なし。

表１　被験者背景

症例数	37 例（男 31 例，女 6 例）
現存歯数	25.4 本(min.20 本，max.30 本)
平均ＰＤ	2.2 ㎜（min,1.4 ㎜，max.3.2 ㎜）
平均最大ＰＤ	5.8 ㎜（min,3 ㎜，max.㎜）

図１　歯周病関連菌の検出状況

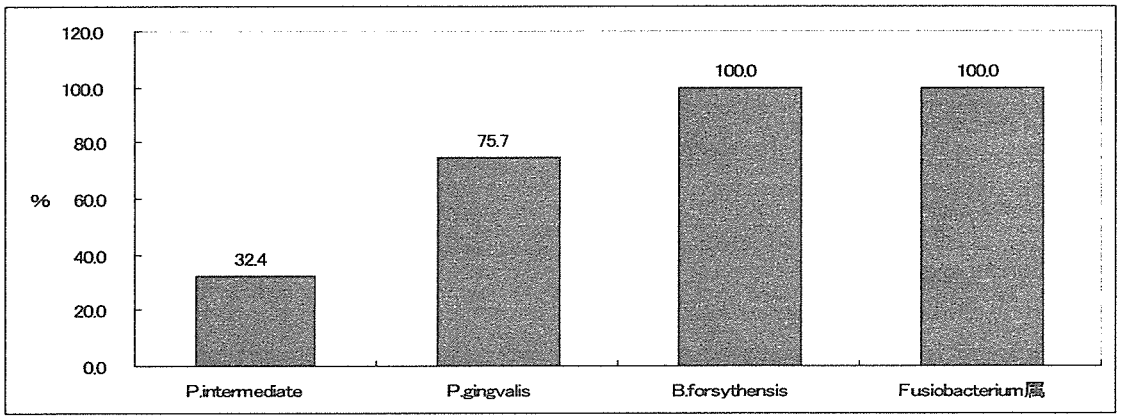

表２－１　歯周病関連菌数と唾液由来 VSC の関係

	P. intermediate		*P. gingivalis*		*T. forsythensis*		*Fusobacteri* 属	
	相関係数	p 値	相関係数	p 値	相関係数	p 値	相関係数	p 値
H_2S	-	0.5392	-	0.1082	-	0.3250	-	0.2377
CH_3SH	0.514	0.0021	-	0.3829	-	0.0910	0.3470	0.0373
総 VSC 濃度	-	0.7246	0.328	0.0491	-	0.1166	0.3590	0.0311
CH_3SH/H_2S 比	0.434	0.0092	-	0.7510	-	0.2636	-	0.2360

Spearman の順位相関

表２－２　歯周病関連菌の割合と唾液由来 VSC の関係

	P. intermediate (%)		*P. gingivalis* (%)		*T. forsythensis* (%)		*Fusobacteri* 属 (%)	
	相関係数	p 値	相関係数	p 値	相関係数	p 値	相関係数	p 値
H_2S	-	0.3503	-	0.3690	-	0.2889	-	0.1111
CH_3SH	0.501	0.0026	-	0.2114	-0.409	0.0140	-	0.0866
総 VSC 濃度	-	0.9768	-	0.7444	-	0.8656	-	0.4222
CH_3SH/H_2S 比	0.452	0.0067	-	0.3707	-0.3310	0.0472	-	0.0786

Spearman の順位相関

図２－１　測定機器の違いによる硫化水素測定値の比較（唾液由来）（単位 ppb）

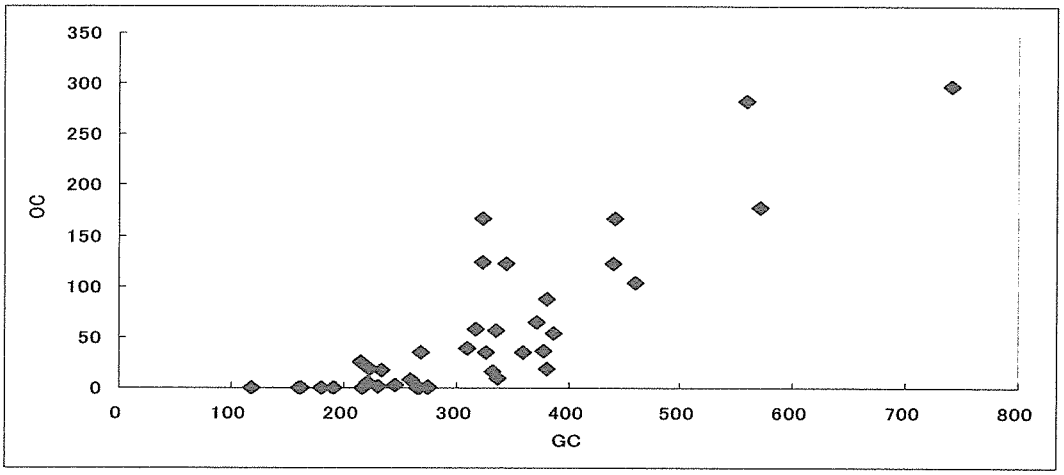

図２－２　測定機器の違いによるメチルメルカプタン測定値の比較（唾液由来硫）（単位 ppb）

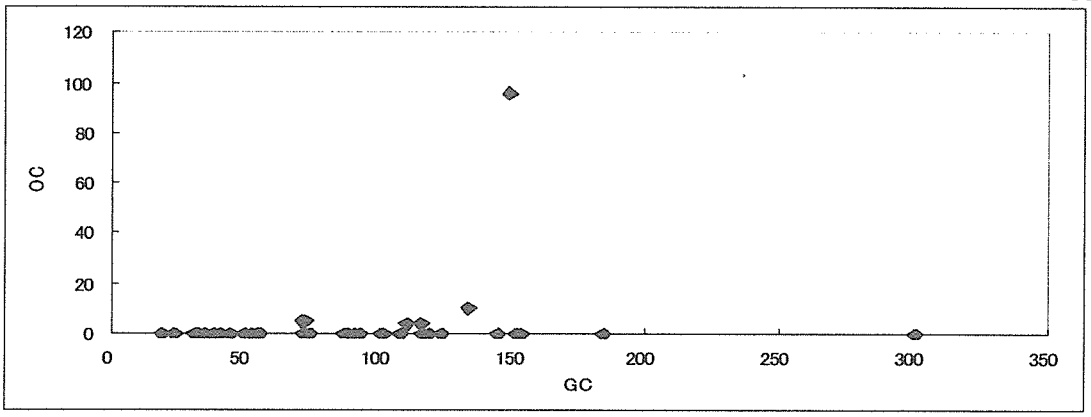

表３　唾液由来 VSC 濃度と歯周組織状況との関係

	総 VSC 濃度		CH_3SH/H_2S 比	
	相関係数	p 値	相関係数	p 値
唾液流量	-	0.5250		0.0361
主な口腔内総細菌数	0.3730	0.0025	0.5440	0.0011
最大 PD	-	0.1896	-	0.2755
最大LA	-	0.2511	-	0.3535
平均 PD	-0.3640	0.0289	-	0.7307
平均 LA	-	0.2446	-	0.0669
PD≧4mm 部位割合	-	0.1154	-	0.2225
LA≧4mm 部位割合	-	0.5323	-0.370	0.0262
BOP(+)部位割合	-	0.4149	-0.379	0.0231
歯石(+)部位	-	0.6131	-	0.0784

平成18年度厚生科学研究費補助金（医療技術評価総合研究事業）
地域住民の口腔保健と全身的な健康状態との関係についての総合研究

ゼリー摂食嚥下による口腔および咽頭清掃効果の検討に関する研究

分担研究者　植松 宏、秋本紗恵子（東京医科歯科大学）

研究要旨；高齢者の口腔内環境を健康に維持することの重要性は広く理解されてきた。しかし要介護高齢者を中心とした高齢者のための福祉施設や在宅で口腔ケアを行うことは必ずしも簡単ではない。そこで、できるだけ省力化した口腔ケアの方法を考案した。医学部付属病院に入院中の患者16名を対象に、高粘度と低粘度の２種類のゼリーのいずれか夕食後、就寝前に食べさせて、口腔ケアと同等の効果を上げることを目的とした。その結果、高粘度ゼリー群では官能検査のスコアとハリメーターの測定値はともに改善が認められたが、低粘度ゼリー群では完全がみられなかった。舌苔の付着度についてはいずれも有意な改善は見られなかった。その他の調査項目（唾液分泌量、唾液緩衝能、カンジダ菌数、ミュータンス菌数、ラクトバチラス菌数）もゼリーを摂取させるという介入前後で変化がなかった。各検査結果に有意差が見られなかった原因としては、今回の対象者の自立度が高く口腔清掃状況が比較的良好であったため差が出にくかったことが考えられる。

A．研究の目的

要介護高齢者に対する口腔ケアの重要性が保健・医療・福祉の現場で認識され、口腔ケアが実践されるようになってきた。しかし、歯ブラシや歯間ブラシ、スポンジブラシ等を用いた口腔清掃は、介護の現場において介助者に負担を強いることになる。介助者の負担軽減を図るための工夫が必要である。

ところで、適度な粘度をもつ食品や飲料を食後に摂取することによって口腔の食物残渣などが清掃されることは、既に介護の現場で言われている。そこで私たちは粘稠なゼリーの性質に着目して、ゼリーの摂取が口腔および咽頭の清掃に効果があるか否かを明らかにする目的で本研究を行った。

B．研究方法

1）調査対象

東京医科歯科大学医学部附属病院老年病内科に入院中の患者で、RSST（反復唾液飲みテスト）および水飲みテストにて嚥下障害の認められない16名を対象とした。

2）調査方法

対象者に対して患者の基本情報（性別、年齢）、全身状態（主病名、合併症）、身

体機能の評価（ＦＩＭを一部抜粋して利用、食事形態）、口腔内環境の実態と要因（残存歯数、義歯の有無、義歯や歯の汚れ、口腔清掃の頻度、口腔衛生状態、ＰＤＩ）について問診および診査を行った。

アクアジュレTM（フードケア社。以下、高粘度ゼリー）およびアクアジュレTMと同成分で粘度を低く押さえたゼリー（以下、低粘度ゼリー）の２種類のゼリーを用いた。対象者を高粘度ゼリーを摂取する群（8名）と低粘度ゼリーを摂取する群（8名）の２群に分けた。群分けは二重盲検とするため、検査に関わらない者が情報収集項目をもとに行った。

両群ともに5日目から5日間連続して夕食後就寝前にゼリーを食べさせ、1、5、6、10日目の早朝（起床直後）に検査を行った。検査は1)唾液分泌量2)唾液緩衝能3)カンジダ菌数4) ミュータンス菌数5) ラクトバチラス菌数6) 舌苔の付着状況7) 口臭の７項目について行った。結果の統計処理にはStatviewTMを用いてWilcoxonの順位和検定、Mann-WhitneyのＵ検定、カイ２乗検定を行った。

（倫理面への配慮）

調査に先立って研究の趣旨を十分説明し書面による同意を得た。また、本研究は本学付属病院倫理委員会の許可（第117号）を得て行った。

C．結果

１）調査対象者の特徴

両群とも主病名は２型糖尿病が大半を占め（14/16名）、糖尿病性網膜症、糖尿病性腎症、糖尿病性神経障害に加えて高血圧、高脂血症を合併するものが多かった。また自立度が高く、食事形態も常食がほとんどであった（15/16名）。

高粘度ゼリー群は男性2名、女性2名で年齢は66.8歳（54ー76歳）、低粘度ゼリー群は男性3名、女性5名で年齢は61.5歳（28ー77歳）、FIMは高粘度ゼリー群は6.9、低粘度ゼリー群は6.8であった。残存歯数は高粘度ゼリー群が14.8±12.8本、低粘度ゼリー群18.4±10.3本であった。２群間に各項目とも統計学的な有意差は認められなかった。

２）１回目と２回目の検査結果の比較

ゼリーを介入しない状態で１日目と５日目に検査を行ったが両群とも各検査結果に有意差は認められなかった。

３）１回目と３回目の検査結果の比較

ゼリーを一回摂取した後の効果を調べたが、両群とも各項目において有意差は認められなかった。

４）１回目と４回目の検査結果の比較

ゼリーを５日連続で摂取した後の効果を調べた。両群とも各項目において有意差は認められなかった。

またゼリー摂取による効果をみるために舌苔、口臭について介入前（１回目）と４回目の検査結果の値を比較した。値の減少したものを「改善」、変わらなかったものを「変化なし」、増加したものを「悪化」として介入前後の変化をみた（図1-1.2）。

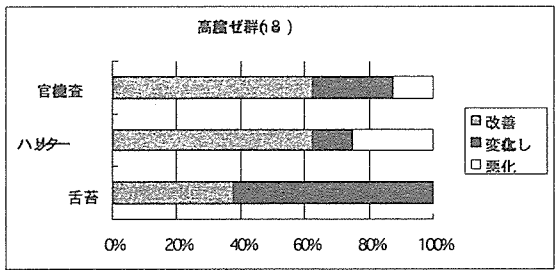

図１-1　ゼリー摂取による効果の比較

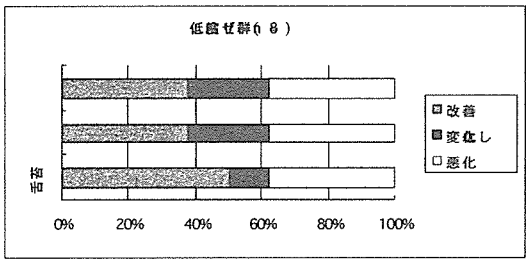

図１-1　ゼリー摂取による効果の比較

高粘度ゼリー群では官能検査のスコアとハリメーターの測定値はともに「改善」が６割以上を占めていたが、低粘度ゼリー群では両者とも「改善」が４割に満たなかった。

舌苔の付着度については高粘度ゼリー群では「変化なし」が６割以上を占め、低粘度ゼリー群では約５割が「改善」を示した反面、「悪化」が約４割を占めていた。

なお高粘度ゼリー群と低粘度ゼリー群の結果の間に、統計学的な有意差は見られなかった。

その他の調査項目（唾液分泌量、唾液緩衝能、カンジダ菌数、ミュータンス菌数、ラクトバチラス菌数）については、介入の前後で「変化なし」がほとんどを占めていた。

D．考察

高齢者の口腔内環境を健康に維持することの重要性は広く理解されてきた。しかし要介護高齢者を中心とした高齢者のための福祉施設や在宅で口腔ケアを行うことは必ずしも簡単ではない。そこで、できるだけ省力化した口腔ケアの方法を考案した。今回ゼリーの摂取が、口腔および咽頭の清掃において効果があるか否かについて予備的な研究を行った。

今回研究対象としたのは医学部付属病院に入院中の 60 歳代の患者が中心であった。そのため、全体に ADL は高く歯磨きなども自分で行っている人たちであった。患者の属性については２群間に各項目とも統計学的な有意差は認められず、偏りなく群分けできたと言える

各検査結果をみると、統計学的な有意差は見られず、今回の結果からは 60 歳代を中心とした入院患者にゼリーの摂取させることは口臭の改善はみられたが、その他の検査結果に差はみられず、口腔および咽頭の清掃において効果がみられたとはいえない。各検査結果に有意差が見られなかった原因としては、対象者の FIM の値が高く口腔清掃状況が比較的良好であったため差が出にくかったこと、ゼリーを摂取してから検査までの時間が長くなったことなどが考えられる。

しかしながら本研究の目的である口腔ケアの省力化は必要であり、今後は要介護高齢者など対象を変え、調査方法についても改善すべき点を考慮した上で継続して研究を進めて行きたいと考えている。

E．結論

自立度の高い入院患者に対するゼリー摂取による、口腔および咽頭の清掃効果については口臭の改善がみられた。しかし唾液分泌量、唾液緩衝能、カンジダ菌数、ミュータンス菌数、ラクトバチラス菌数などその他の指標に改善は認められなかった。本研究の目的を考えると、より自立度の低い患者に対する調査が望まれる。

G.研究報告

1．論文発表

なし

2．学会発表

なし

H.知的財産権の出願・登録状況

なし

研究成果の刊行に関する一覧表

書籍

著者氏名	論文タイトル名	書籍全体の編集者名	書　籍　名	出版社名	出版地	出版年	ページ

雑誌

発表者氏名	論文タイトル名	発表誌名	巻号	ページ	出版年
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Y. Saotome, A. Tada, N. Hanada, A. Yoshihara, H. Uematsu, H. Miyazaki, H. Senpuku	Relationship of cariogenic bacteria levels with periodontal status and root surface caries in elderly Japanese.	Gerodontology.	Dec;23(4):	219-225,	2006
Senpuku H, Tada A, Uehara S, Kariyama R, and Senpuku H.	Post-operative infection by pathogenic micro-organisms in the oral cavity of patients with prostatic carcinoma.	J Int Med Res.	34:	95-102,	2006
Salam MA, Tada A, Yonezawa H, Watanabe H, and Senpuku H	Human T-cell responses to oral streptococci in human PBMC-NOD/SCID mice.	Oral Microbiol Immunol.	21:	169-176.	2006

J Clin Periodontol 2006; 33: 312–316 doi: 10.1111/j.1600-051X.2005.00901.x

Journal of Clinical Periodontology

Association between serum albumin and periodontal disease in community-dwelling elderly

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Ogawa H, Yoshihara A, Amarasena N, Hirotomi T, Miyazaki H. Association between serum albumin and periodontal disease in community-dwelling elderly. J Clin Periodontol 2006; 33: 312–316. doi: 10.1111/j.1600-051X.2006.00901.x.

Abstract

Aim: The purpose of this study was to evaluate the relationship between periodontal disease and general health status in community-dwelling elderly using serum albumin concentration as a criterion index of the severity of an underlying disease and nutrition status.

Methods: Serum albumin level was detected by the bromcresol green albumin (BCG) method and the data for serum albumin were available in 368 subjects aged 75 years. Pressure-sensitive probes were used to measure loss of attachment (LA) on six sites of all teeth present. Information relevant to gender and smoking habit was obtained by means of a personal interview, while body mass index (BMI) and biochemical serum markers were investigated.

Results: Serum albumin concentration ranged from 3.2 to 4.8 g/dl with a mean of 4.1 ± 0.2. More than 70% of subjects had at least one site with LA 6+ mm, while 91 exhibited 10% or more sites with LA 6+ mm. Using a multiple regression analysis, we found that sites of LA 6+ mm had a significant effect on serum albumin level (correlation coefficient = -0.14; $p<0.05$), which was independent of the other covariates.

Conclusions: The findings of the present study indicated that there might be an inverse relationship between periodontal disease and serum albumin concentration in these elderly subjects.

Key words: elderly; epidemiology; nutrition; periodontal disease; serum albumin

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Periodontal infection has been implicated as a risk factor for systemic diseases such as coronary heart disease and diabetes (Genco et al. 2001, Taylor 2001, Nishimura et al. 2003). It has been suggested that impaired dentition status such as tooth loss owing to periodontal infection may affect individuals by causing dietary restrictions via difficulty in chewing, possibly compromising their nutritional status and well-being (Chauncey et al. 1984, Papas et al. 1989, Hollister & Weintraub 1993). However, the association between periodontal disease and general health, including nutritional status, in the elderly who may be at a higher risk of developing inflammatory conditions or disorders is still unclear.

Serum albumin levels might be a practical marker of the general health status as they describe the severity of an underlying disease and mortality in elderly (Phillips et al. 1989). According to Herrmann et al. (1992), many conditions, such as inflammatory states, liver diseases and renal diseases, have been indicated to reduce serum albumin levels. Moreover, malnutrition also may be monitored by means of the serum albumin concentration (Don & Kaysen 2004). Serum albumin levels remain virtually unchanged even in the presence of protein calorie malnutrition in otherwise healthy individuals until near terminal starvation. It may be suggested that lower albumin levels have a complex aetiology rather than reduced protein intake alone contributing to hypoalbuminaemia (Rigaud et al. 2000).

In terms of association between oral disease and serum albumin concentration, Yoshihara et al. (2003) have recently reported that the number of untreated teeth was a significant factor associated with serum albumin concentration in elderly. Therefore, it is apparent that oral disease burden might be indicated and monitored by the levels of serum albumin; however, few studies have been performed or reported to see the relationship between periodontal disease status and serum albumin concentration.

Consequently, we adopted the serum albumin concentration as a criterion, which indicates the general health

condition including nutrition status, and designed this study to investigate how periodontal disease condition may influence the serum albumin concentration in the elderly.

Materials and Methods

At the beginning, 4542 (2099 males and 2443 females) Niigata citizens aged 70 years were sent a written request to participate in the survey and were informed of the purpose of this survey. After two requests, 81.4% (3695) responded positively to participate in the survey. Considering the availability of resources, appointments for examinations could be arranged only for 600 persons. The final study sample was randomly recruited from several divisions in Niigata in order to have an approximately equal number of males (306) and females (294). All subjects agreed and signed informed consent forms regarding the protocol, which was reviewed and approved by the Ethics Committee of the Faculty of Dentistry, Niigata University. The subjects who participated in the survey in 1998 were recalled and re-examined in 2003. Among them, 368 (194 males and 174 females) subjects examined as dentate in 2003 and in whom the levels of serum albumin were evaluated were targeted for this cross-sectional study.

None of the subjects was hospitalized or institutionalized. They did not require special care for their daily activities, and had high scores of reliability and validity in a multidimensional 13-item index of competence (TMIG index of competence) (Koyano et al. 1991).

A personal interview was conducted to obtain the information regarding gender, smoking habit. Anthropometric evaluation included measurements of weight and height for the calculation of body mass index (BMI). In addition, biochemical values such as total protein, calcium, total cholesterol, c-reactive protein, high-density lipoprotein (HDL)-cholesterol, triglyceride and immunoglobulin G (IgG) were also evaluated, while the serum level of albumin was measured by the bromcresol green albumin (BCG) method. Four dentists carried out intra-oral examination under sufficient illumination using artificial light. The periodontal condition, measured as loss of attachment (LA), was recorded using mouth mirrors and specially designed pressure-sensitive Vivacare, TPS Probe® (Vivacare, Schaan, Liechtenstein). Probing was performed at six sites per tooth for all teeth present, and the measurements were recorded approximately to the nearest whole millimetre. The examiners were calibrated both before and during the survey, and κ values between each pair of examiners were in the range of 0.62–1.00 for assessing the attachment level.

Statistical analyses were performed as follows. Initially, serum albumin concentration was considered as a dependent continuous variable and the unit of analysis was the subject. Gender (male, female), smoking habit (yes, no), BMI (<20, $\geqslant 20$), the percentage of sites with LA 6+ mm ($<10\%$, $\geqslant 10\%$) and the number of teeth present (<20, $\geqslant 20$) were selected as independent variables. Student's *t*-test was employed to compare the difference between two means. In addition, the relationship between serum albumin concentration and percentage of sites of LA 6+ mm and serum values for nutritional and biochemical parameters were evaluated by Student's *t*-test. Finally, a multiple linear regression analysis was used to estimate the independent effect of periodontal disease status on serum albumin level while controlling for confounding factors. Serum albumin concentration was used as the dependent variable, while the variables that showed significant relationships with serum albumin concentration at $p \leq 0.05$ in initial analyses were selected as independent variables. All calculations and statistical analyses were performed using the STATA® software package.

Results

Out of the sample, 48.1% of subjects had smoking experience, while 12.8% of them were current smokers. The mean number of remaining teeth was 18.1 per subject. More than 70% of subjects had at least one site with LA 6+ mm, while 91 (24.7%) exhibited 10% or more of sites with LA 6+ mm as severe periodontal disease. The serum albumin level of the sample was 3.2 to 4.8 g/dl with a mean of 4.1 ± 0.2 (results not shown in the table).

Table 1 shows the relationship between individual characteristics, dental status and serum albumin concentration. Male subjects or smokers* showed a significantly lower level of serum albumin ($p<0.001$, $p = 0.008$*), respectively. Subjects with 10% or more sites of LA 6+ mm also showed lower serum albumin concentration compared with subjects who have less than 10% of sites with LA 6+ mm ($p = 0.003$). There were no significant differences between number of teeth present, BMI and serum albumin concentration. Relations between serum albumin and serum parameters for nutritional and biochemical values are listed in Table 2. Subjects with a lower level of total protein (<6.5 g/dl), calcium (<4.5 mEg/l), c-reactive protein (>0.45 mg/dl) and total cholesterol (<150 mg/dl) had significantly lower serum albumin concentrations ($p<0.001$). In addition, the subjects with a lower level of total cholesterol and a higher level of c-reactive protein* had a significantly greater percentage of sites with LA 6+ mm ($p<0.001$, $p<0.05$*), respectively. Table 3 shows the final multiple regression models for serum albumin alongside the independent variables that demonstrated significant effects on serum albumin. It was found that percentage of sites of LA 6+ mm had a significant effect on serum albumin (correlation coefficient = -0.14; $p<0.05$), which was independent of the other covariates.

Table 1. Relationship between serum albumin, subject characteristics and dental status

	Serum albumin (g/dl): mean (SD)	*p*-value
Gender		
Male	4.07 (0.23)	<0.001
Female	4.18 (0.22)	
Smoking habit		
Yes	4.08 (0.24)	0.008
No	4.15 (0.22)	
BMI		
<20	4.10 (0.27)	NS
⩾20	4.12 (0.23)	
% of sites with LA 6+ mm		
<10%	4.14 (0.23)	0.003
⩾10%	4.06 (0.22)	
No. of teeth present		
<20	4.11 (0.22)	NS
⩾20	4.13 (0.24)	

NS: not significant.

Discussion

In this cross-sectional investigation, a significant association was found between periodontal disease as measured by percentage of sites with LA 6+ mm and the serum albumin concentration. In

Table 2. Relationship between serum albumin, periodontal disease and serum bloods parameters for nutritional and biochemical values

Parameters	Category	No. of subjects	Serum albumin (g/dl)			Sites with LA 6+ mm	
			mean	SD	*p*-value	%	*p*-value
Total protein (g/dl)	<6.5	17	3.78	0.24	<0.001	7.7	NS
	6.5–8.2	344	4.14	0.22		8.3	
	>8.2	5	4.04	0.19		13.5	
Calcium (mEg/l)	<4.5	88	3.95	0.23	<0.001	7.9	NS
	⩾4.5	278	4.17	0.21		8.5	
Total cholesterol (mg/dl)	<150	17	3.96	0.26	<0.001	21.4	<0.001
	150–219	250	4.09	0.23		8.6	
	⩾220	99	4.22	0.22		5.4	
C-reactive protein (mg/dl)	⩽0.45	354	4.13	0.23	<0.001	8.0	<0.05
	>0.45	12	3.87	0.24		16.4	
HDL-cholesterol (mg/dl)	<40	28	4.05	0.22	NS	9.5	NS
	⩾40	338	4.13	0.24		8.2	
Triglyceride (mg/dl)	<50	16	4.04	0.28	NS	12.4	NS
	50–149	231	4.11	0.24		8.6	
	⩾150	118	4.15	0.22		7.4	
IgG (g/dl)	<1000	39	4.16	0.25	NS	4.8	NS
	1000–1900	316	4.12	0.23		8.6	
	>1900	11	3.98	0.19		13.8	

NS: not significant.

Table 3. Multiple linear regression and associated *p*-values

Independent variables	Dependent variable serum albumin (g/dl)				
	coefficient	standarad error	*p*-value	95% CI	
% of sites with LA 6+ mm	−0.137	0.067	<0.05	−0.268	−0.048
Total protein(g/dl)	0.146	0.023	<0.001	0.100	0.192
Calcium (mEg/l)	0.490	0.057	<0.001	0.377	0.602
Total cholesterol (mg/dl)	0.001	0.000	0.001	0.001	0.002
C-reactive protein(mg/dl)	−0.117	0.029	<0.001	−0.174	−0.060
Gender	0.041	0.030	0.173	−0.018	0.101
Smoking habit	−0.050	0.029	0.087	−0.108	0.007
Constant	0.638	0.237	<0.05	0.172	1.103

$p<0.001$, $R^2 = 0.4503$.

fact, we observed an inverse independent relationship between periodontal disease and serum albumin concentration. Some epidemiological studies have demonstrated a relationship between dental status and level of serum albumin. According to Mojon et al. (1999), institutionalized older adults (mean age = 85 years) who had teeth with vertical mobility combined with periodontal pockets greater than 6+ mm had a significantly lower serum albumin concentration (3.3 g/dl). More recently, Yoshihara et al. (2003) reported that the number of untreated teeth was a significant factor associated with lower serum albumin concentration in an elderly population. Accordingly, our results have supported previous reports indicating an association between oral health status, in particular periodontal disease, and level of serum albumin.

Hypoalbuminaemia may be linked to various adverse effects. Several researchers have proposed an association between serum albumin level and mortality rate. Corti et al. (1994) investigated the relationship between serum albumin level and all-cause mortality in an elderly population aged 71+ years, and reported graded increase in mortality rate with decreasing albumin level while hypoalbuminaemia was associated with a significantly increased mortality rate. Phillips et al. (1989) also reported that there was a marked increase in mortality rate with decreasing serum albumin concentrations that persisted even after adjusting for age, social class, town of residence, cigarette smoking, serum total cholesterol, serum total calcium and systolic blood pressure. Moreover, according to Shibata et al. (1991), subjects aged 69–71 years who were divided into four groups by the quartile of serum albumin levels (−4.1, 4.2–4.3, 4.4–4.5, 4.6+ g/dl) had significantly different 10-year survival rates. Even a difference in survival rates between the first and second quartiles was evident. Therefore, the present findings indicated that periodontal disease status denoted by the percentage of sites with LA 6+ mm might have a substantial influence not only on the subjects' serum albumin levels but also on general health aspects.

Although the precise mechanism underlying the serum albumin–periodontal relationship is not well understood, we hypothesize that this relationship might be explained by the following two conceivable possibilities, namely, the influence of nutritional aspect or chronic disease aspect (Yoshihara et al. 2003). According to our results, serum albumin concentration was significantly associated with lower levels of total protein, calcium, c-reactive protein and total cholesterol. In addition, our subjects with less than 150 mg/dl of total cholesterol and more than 0.45 mg/dl of c-reactive protein* showed significantly lower serum albumin levels and a higher percentage of sites with LA 6+ mm ($p<0.001$, $p<0.05$*), respectively. Therefore, our results suggested that not only the nutritional aspect but also the inflammatory reactants might be influenced by both serum albumin concentration and periodontal disease condition. Indeed, several reports have indicated a relation between nutritional condition and serum albumin (Magagnotti et al. 2000, Giordano et al. 2001), though a few studies have observed an association between nutritional aspects (mainly vitamin C) and periodontal disease (Ismail et al. 1983, Nishida et al. 2000, Amarasena et al. 2005).

A significant association between serum albumin concentration and IgG has also been reported (Goubran Botros et al., 1996). C-reactive protein is not a nutritional parameter but may be used to identify the presence of inflammation in individuals with a lower serum albumin concentration (Gabay & Kushner 1999). The level of serum albumin may fall owing to a variety of infections with an increase of c-reactive protein and IgG, concentration. Elevated c-reactive protein

and IgG levels in periodontal patients have been reported (Noack et al. 2001, Sahingur & Cohen 2004). The present study, however, failed to show a statistically significant correlation between serum albumin and IgG though c-reactive protein had such an association. The serum albumin concentration showed a tendency to decrease with increasing levels of IgG. A statistically significant association was not found between IgG and periodontal disease conditions.

Considering these results, it could be suggested that the significant relationship between periodontal disease and serum albumin concentration in our subjects might be influenced by nutritional aspects rather than chronic infectious disease. On the other hand, Mojon et al. (1999) reported that a compromised oral functional status has little influence on the nutritional status of semi-dependent elders, while those in poorer health might be more susceptible to poor oral function. In addition, the rate of albumin synthesis in elderly subjects might not be sensitive to changes in protein intake (Walrand et al. 2000). It has also been reported that synthesis speed of albumin in the liver in the elderly is not influenced by the ingestion of protein.

As there is no uniformity in case definitions or the method used among studies, the effect of periodontal disease on the level of serum albumin that has been shown by these studies is strictly not comparable. Moreover, this study population may be considered a biased one as it consisted of generally dynamic, independent and non-institutionalized elderly people who volunteered to participate in the survey (Amarasena et al. 2005). It has been observed that such non-institutionalized elderly who are active and independent may be less prone to severe periodontal disease than institutionalized elderly who are less active and dependent (Hirotomi et al. 2002, Ogawa et al. 2002).

In view of these facts, and because of the cross-sectional design of the present study, we cannot confirm a clear cause–effect relationship between serum albumin and periodontal disease at this stage. In order to explore the actual relationship between periodontal disease status and serum albumin level, further prospective studies and clinical trials will be necessary.

In conclusion, the findings of the present study might point to a statistically significant association between periodontal disease status and serum albumin concentration in this elderly population.

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Clinical Relevance

Scientific rationale: Oral health may be integral to general health and essential for the well-being of the elderly.

Principal findings: Periodontal disease condition might be linked with reduced levels of serum albumin, which in turn could be caused by nutritional status in the elderly.

Practical implications: Appropriate care and cure for periodontal disease may contribute to maintain good general health and it could be monitored through the level of serum albumin.

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A preliminary study on the relationship between stimulated saliva and periodontal conditions in community-dwelling elderly people

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ABSTRACT

Objectives: The purpose of this study was to explore the relationship between flow rate and spinnbarkeit of stimulated whole saliva and periodontal conditions in healthy elderly people.

Methods: Three hundred and fifty-five dentate subjects aged 76 years were included. The pocket probing depth (PD), attachment level (AL), and bleeding on probing (BOP) were measured. Stimulated whole saliva was collected and the salivary flow rate (SFR) was calculated. Then, salivary spinnbarkeit (SS) was immediately measured.

Results: The mean SFR and SS were 1.44 ml/min and 1.91 mm, respectively. SFR was not significantly related to each periodontal parameter. On the other hand, subjects with SS $\leq$ 2.00 mm had a significantly lower mean AL ($p < 0.05$). When subjects were divided into four groups according to a combination of SFR and SS, subjects with SFR < 0.7 ml/min and SS > 2.00 mm exhibited a significantly higher mean PD ($p < 0.05$), % of sites with PD $\geq$ 4 mm ($p < 0.05$), mean AL ($p < 0.01$), % of site with AL $\geq$ 4 mm ($p < 0.05$) and % of sites with AL $\geq$ 6 mm ($p < 0.01$) than subjects in the other three groups (one-way ANOVA). In the logistic regression analysis, the factors significantly associated with the highest quintile of PD $\geq$ 4 mm were: the low salivary flow and the high salivary spinnbarkeit (OR 3.84), current smokers (OR 5.08), cleaning interdental spaces rarely/never (OR 2.12), and frequent BOP (OR 5.20).

Conclusion: These findings suggest that high salivary spinnbarkeit in addition to a low salivary flow rate might be a high risk for periodontal disease in elderly people.

1. Objectives

The reduction of salivary flow is widespread in elderly people. One of the main factors causing reduced salivary flow is medication.[1,2] A wide variety of medications may reduce salivary flow by mimicking autonomic nervous system actions, or by acting directly on the cellular processes necessary for salivation.[3] Various systemic diseases, including Sjögren's syndrome,[4,5] diabetes mellitus,[6,7] and neurological disorders[8,9] also affect salivation. As saliva plays an important

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role in maintaining oral functions, decreased salivary flow would make adverse effects on oral conditions. It is reported that in patients whose salivary glands had been irradiated for head and neck cancer, the damage of the glands led to the diminished salivary flow[10] and to the development of dental root caries.[11] However, little information is available about the relationship of salivary dysfunction on periodontal health.[12]

The rheological properties of saliva include viscosity, solubility, elasticity and adhesiveness, as a result of the unique chemical and structural characteristics of its mucins.[13] The lubricating action of saliva is essential for oral health. It facilitates movement of the tongue and lips on swallowing and eating. The efficacy of saliva as a lubricant depends on its viscosity.[14] The viscosity of a fluid composed of small molecules depends on the intermolecular attraction forces present, and on the degree of friction between different molecular layers moving in parallel within the fluid.[15] It has been shown that increased salivary viscosity is associated with an increase of dental caries in rats.[16] Additionally, stimulated whole salivary viscosity is greater in vomiting bulimics with severe dental erosion.[17] However, no studies have been previously reported as to the relationship between the physical properties of saliva and the periodontal conditions.

Since saliva is a non-Newtonian fluid, the measurement of salivary viscosity requires the use of a special apparatus called a viscometer.[18–20] Disadvantage of that device is that it needs considerable time to be used, while it is also expensive and handling is complicated. On the other hand, spinnbarkeit is the thread-forming capacity of mucus under the influence of large-amplitude elastic deformation and it gives information about the internal cohesion forces of the mucus.[21] Factors that control mucus spinnbarkeit are the concentration of mucous glycoproteins, the degree of intermolecular and intramolecular cross-linkings, and the hydration of mucus.[22–24] Recently, salivary spinnbarkeit has been shown to correlate positively with salivary viscosity and to be measured quickly and easily.[25]

Thus, it was hypothesized that salivary spinnbarkeit in combination with the flow rate would be associated with periodontal disease. The purpose of this preliminary study was to explore the relationship of the flow rate and spinnbarkeit of stimulated whole saliva on the periodontal conditions in elderly people.

2. Methods

Subjects included in this cross-sectional study were recruited from people born in 1927, residing in the city of Niigata, Japan. The study population consisted of community-dwelling, independently living elderly people aged 76 years. Six hundred subjects were randomly selected from the target population and 413 subjects participated in this study. Of these 413 subjects, 366 were dentate. Among them, this study analyzed 355 dentate subjects from whom a salivary sample was able to be collected.

The periodontal examination was carried out by four trained dentists. All subjects were examined at local community centers in Niigata City. Mouth mirrors incorporating a light and pressure-sensitive plastic periodontal probes, set to give a constant probing force of 20 g and graduated at 1 mm intervals (VIVACARE TPS PROBE®) were used. All functioning teeth including third molars were assessed, except for partially erupted teeth. The pocket probing depth (PD) and attachment level (AL) were measured at six sites per tooth (mesio-buccal, mid-buccal, disto-buccal, mesio-lingual, mid-lingual and disto-lingual) and rounded to the nearest whole millimeter. In cases where a restorative margin was apical to the cemento-enamel junction (CEJ), AL was measured taking into account the anatomical features of the teeth and, if present, the CEJ of the adjacent tooth/teeth. Also, bleeding on probing (BOP) was measured at six sites per tooth. Before and during the survey, calibrations were conducted in an institution for the aged and the Faculty Hospital of Dentistry, Niigata University. Interexaminer agreements ranged from 86.6 to 95.9% and from 65.8 to 94.4% for PD and AL, respectively. Kappa values ranged from 0.79 to 0.93 and from 0.56 to 0.92 for PD and AL, respectively.

Stimulated whole saliva was collected from 355 dentate subjects. Subjects chewed a 1 g piece of paraffin wax for 1 min, and after swallowing once, they expectorated secreted saliva into a test tube. Collection time was 3 min and flow rate was calculated as ml/min. The stimulated salivary flow rate (SFR) was classified as either less than 0.7 ml/min (low) or 0.7 ml/min or more (normal). After stimulated whole saliva was collected, the salivary spinnbarkeit (SS) was immediately measured using the recently developed Neva Meter™ (IMI-001 Ishikawa Ironworks Co. Ltd., Japan). The Neva Meter was shown to be able to objectively measure the spinnbarkeit of saliva with acceptable reproducibility.[25] The Neva Meter is based on the principle that electrical resistance approaches infinity at the cutting position. After a saliva sample is introduced to the bottom reservoir of the device, it is automatically stretched at a constant rate of 5 mm/s. Next, application of an electrical current (5 V) to the liquid induces a microcurrent, which stops at the moment the thread breaks. The device detects the point at which the current stops and then measures the maximum length (in millimeters) of the thread, i.e., the spinnbarkeit. Measurements were taken five times consecutively and the spinnbarkeit was calculated by averaging three of five values, excluding the highest and lowest readings. The SS was classified as either more than 2.00 mm (high) or 2.00 mm or less (normal) based on the distribution. Because room humidity may also affect the SS,[22,24] the temperature and humidity were maintained throughout the measurements at 22–26 °C and 55–60%, respectively.

In periodontal epidemiology, the mean values on PD and AL were widely used for describing periodontal conditions. However, it is also widely recognized that the mean values alone do not adequately describe the nature of periodontal disease in populations, because of marked variation between and within subjects. Therefore, percentages of sites with PD $\geq$ 4 mm and AL $\geq$ 4 mm, respectively, were calculated as representing the severity of moderate periodontal disease. Similarly, percentages of sites with PD $\geq$ 6 mm and AL $\geq$ 6 mm, respectively, were calculated as representing the severity of severe periodontal disease.

Information about the subjects' smoking status was obtained from a questionnaire. Subjects were asked about their use of cigarettes and categorized as current smokers, former smokers, or never smokers. The questionnaire also gave information about oral hygiene habits: frequency of interdental cleaning (daily/frequently versus rarely/never) and the last dental visit (within 1 year versus more than 1 year).

Since all subjects had participated in a medical examination prior to the oral examination, the number of prescription medications that they were taking and the number of diseases for which they were currently being treated were also confirmed from physicians' examination records. The number of prescription medications was dichotomized: no medications, from 1 to 4 different medications, and ≥5 different medications. Similarly, subjects were categorized according to the number of systemic diseases: no diseases, from one to two different diseases, and from three to five different diseases.

Data analysis was performed using STATA software (Stata 6.0 for Windows, Stata Corporation, College Station, TX, USA). The chosen level of statistical significance was 5%. In salivary and periodontal parameters, the means and standard deviations were calculated and the Student *t*-test and the one-way analysis of variance (ANOVA) were used to analyze differences between the groups. Multivariate logistic regressions were used for analysis of the effect of the low SFR (<0.7 ml/min) and the high SS (>2.00 mm) on periodontal conditions in order to adjust for other confounding factors: gender, the number of teeth present, smoking status, the number of prescription medications and systemic diseases, and oral hygiene habits. The dependent variable was the periodontal condition defined as subjects in the highest 20th percentile in each examined parameter, i.e., subjects with mean PD > 2.5 mm, >17.5% of sites with PD ≥ 4 mm, >2.0% of sites with PD ≥ 6 mm, mean AL > 4.0 mm, ≥68.0% of sites with AL ≥ 4 mm, and ≥12.2% of sites with AL ≥ 6 mm were classified as cases, respectively. In this study, plaque accumulation was not examined. Alternatively, in the light of periodontal etiology, BOP was used as an independent variable: whether subjects with >19.4% (the highest 20th percentile) of sites with BOP or not.

3. Results

In this elderly population, the percentages of current, former, and never smokers were 12.8, 34.3, and 53.0%, respectively. Most of female subjects (92.8%) were never smokers. Subjects using no prescription medications, from 1 to 4 medications, and ≥5 medications were 42.8, 36.3, and 20.9%, respectively. The mean number of medications used was 2.4 and no significant difference between genders was found. The percentages of subjects with no systemic diseases, from one to two different diseases, and from three to five diseases were 22.0, 69.5, and 8.5%, respectively. The mean number of diseases for which they were currently being treated was 1.3 and no significant difference between genders was also found. The mean number of teeth present in males and females was 18.8 and 17.5, respectively, with no significant gender differences.

Table 1 shows the mean values on salivary parameters by gender, the number of prescription medications, and the number of systemic diseases. The distribution of SFR ranged from 0.07 to 4.13 ml/min and SFR ≥ 0.7 ml/min was found in 79.4% of subjects. The mean SFR was 1.44 ± 0.83 ml/min with a significantly higher value in males than in females. There were no significant relationships of SFR on the number of medications and systemic diseases. The distribution of SS ranged between 0.97 and 3.84 mm and 77.5% of subjects had SS ≤ 2.00 mm. The mean SS was 1.91 ± 0.37 mm, with a slightly higher value in males. However, there was no significant difference between genders. Also, there were no significant relationships of SS on the number of medications and diseases.

The mean values on periodontal parameters by the various subject characteristics were shown in Table 2. Significantly higher mean values on all periodontal parameters, except for BOP, were found in males compared with females. For example, the percentages of sites with AL ≥ 4 mm were, respectively, 44.0 ± 29.5 and 28.9 ± 24.2 in males and females, with a significance level of $p < 0.001$. In all periodontal parameters, those who had fewer teeth were most affected.

Table 1 – The mean values on salivary parameters by gender, number of prescription medications, and number of systemic diseases

Subject characteristics	*n*	Salivary flow rate (ml/min)	Spinnbarkeit of saliva (mm)
Gender			
Male	188	1.62 ± 0.93***	1.95 ± 0.42 NS
Female	167	1.23 ± 0.65	1.87 ± 0.31
Number of medications			
0	152	1.50 ± 0.83 NS	1.92 ± 0.35 NS
1–4	129	1.40 ± 0.80	1.90 ± 0.37
5≤	74	1.38 ± 0.87	1.91 ± 0.42
Number of diseases[a]			
0	78	1.54 ± 0.84 NS	1.92 ± 0.39 NS
1–2	246	1.41 ± 0.84	1.92 ± 0.38
3–5	30	1.43 ± 0.76	1.86 ± 0.27

Mean values ± S.D. are given. NS: not significant. P values between genders were obtained from Student t-test and in other variables from one-way analysis of variances.

[a] Data missing for one subject.

*** $p < 0.001$.

Table 2 – The mean values on periodontal parameters by gender, number of teeth present, smoking status, and oral hygiene habits

Subject characteristics	*n*	Mean PD (mm)	% sites with PD ≥ 4 mm	% sites with PD ≥ 6 mm	Mean AL (mm)	% sites with AL ≥ 4 mm	% sites with AL ≥ 6 mm	% sites with BOP
Gender								
Male	188	2.2 ± 0.5***	12.3 ± 12.9***	2.1 ± 4.4**	3.6 ± 1.1***	44.0 ± 29.5***	11.1 ± 16.2***	11.5 ± 12.4 NS
Female	167	2.1 ± 0.4	7.9 ± 9.4	1.0 ± 2.5	3.0 ± 0.8	28.9 ± 24.2	4.0 ± 7.7	12.4 ± 13.9
Number of teeth present								
1–9	73	2.3 ± 0.6*	14.1 ± 15.9**	3.0 ± 6.2***	4.1 ± 1.3***	58.8 ± 29.1***	17.7 ± 20.9***	18.5 ± 17.4***
10–19	97	2.2 ± 0.5	11.1 ± 11.0	1.5 ± 2.8	3.4 ± 0.9	40.6 ± 27.3	8.5 ± 12.3	11.7 ± 12.8
20–32	185	2.1 ± 0.4	8.2 ± 9.2	1.0 ± 2.4	2.9 ± 0.7	26.3 ± 22.1	3.4 ± 6.1	9.4 ± 10.0
Smoking status[a]								
Current	45	2.4 ± 0.5***	15.8 ± 12.8***	1.4 ± 2.0*	3.8 ± 1.1***	49.2 ± 29.1***	13.7 ± 19.5***	9.2 ± 9.5 NS
Former	121	2.2 ± 0.5	11.8 ± 13.5	2.2 ± 4.9	3.5 ± 1.1	42.5 ± 29.4	10.2 ± 15.5	13.1 ± 13.9
Never	187	2.1 ± 0.4	7.8 ± 9.1	1.1 ± 3.0	3.0 ± 0.8	29.9 ± 24.8	4.7 ± 8.6	11.7 ± 13.2
Interdental cleaning[b]								
Daily/frequently	183	2.0 ± 0.4***	7.1 ± 8.2***	1.0 ± 2.3**	3.0 ± 0.9***	29.9 ± 26.2***	5.4 ± 9.6***	7.7 ± 9.8***
Rarely/never	169	2.3 ± 0.5	13.5 ± 13.6	2.2 ± 4.7	3.6 ± 1.1	43.7 ± 28.1	10.2 ± 16.3	16.5 ± 14.6
Last dental visit[b]								
Within 1 year	248	2.1 ± 0.5 NS	9.6 ± 11.2NS	1.5 ± 3.3 NS	3.2 ± 0.9 NS	34.8 ± 27.4*	7.1 ± 12.3 NS	10.6 ± 12.6**
More than 1 year	104	2.2 ± 0.5	11.8 ± 12.3	1.8 ± 4.5	3.5 ± 1.1	41.3 ± 28.9	9.2 ± 15.8	15.1 ± 13.6

Mean values ± S.D. are given. NS: not significant. *P* values in variables with two alternatives were obtained from Student *t*-test and in variables with three alternatives from one-way analysis of variances.
[a] Data missing for two subjects.
[b] Data missing for three subjects.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

For example, while subjects with 1–9 teeth had 17.7% of sites with AL ≥ 6 mm, subjects with 20–32 teeth had only 3.4% of such sites. Smoking status also had a significant influence on periodontal conditions. In most parameters, severe periodontal conditions were found in current smokers followed by former smokers. Interestingly, current smokers had a lowest percentage (9.2%) of sites with BOP, although the relationship was not significant. The frequency of an interdental cleaning also had a significant association on all periodontal parameters, while the variable on the last dental visit related to two periodontal parameters.

The mean values on periodontal parameters by SFR are shown in Table 3. SFR was not significantly related to each periodontal parameter. On the other hand, subjects with SS > 2.00 mm had a significantly higher mean AL (Table 4).

Table 3 – The mean values on periodontal parameters by salivary flow rate (SFR)

Periodontal parameters	SFR < 0.7 (*n* = 73)	SFR ≥ 0.7 (*n* = 282)
Mean PD (mm)	2.3 ± 0.5	2.1 ± 0.5 NS
% sites with PD ≥ 4 mm	12.5 ± 13.6	9.6 ± 10.9 NS
% sites with PD ≥ 6 mm	2.0 ± 4.9	1.4 ± 3.3 NS
Mean AL (mm)	3.3 ± 1.2	3.3 ± 1.0 NS
% sites with AL ≥ 4 mm	36.7 ± 27.8	36.9 ± 28.2 NS
% sites with AL ≥6 mm	8.7 ± 15.4	7.5 ± 12.9 NS
% sites with BOP	12.1 ± 11.5	11.9 ± 13.5 NS

Mean values ± S.D. are given. NS: not significant. *P* values were obtained from Student *t*-test.

When subjects were divided into four groups according to a combination of SFR and SS, the subjects with SFR < 0.7 ml/min and SS > 2.00 mm showed a significantly higher mean PD (2.5 mm), % of sites with PD ≥ 4 mm (18.7%), mean AL (4.2 mm), % of site with AL ≥ 4 mm (54.3%), and % of sites with AL ≥ 6 mm (19.8%) than subjects in the other three groups, including the group with SFR ≥ 0.7 ml/min and SS > 2.00 mm (Table 5).

In the logistic regression analysis, the factors significantly associated with the worst periodontal condition in relation to the severity of PD ≥ 4 mm were: the low salivary flow and the high salivary spinnbarkeit (OR 3.84, 95% CI 1.15–12.77), current smokers (OR 5.08, 95% CI 1.57–16.44), cleaning interdental spaces rarely/never (OR 2.12, 95% CI 1.08–4.16), and subjects with >19.4% of BOP (OR 5.20, 95% CI 2.58–10.46) (Table 6). Although similar multivariate analyses were performed on other five periodontal parameters, significant findings were not observed.

4. Discussion

This is the first epidemiological study to assess the relationship of flow rate and spinnbarkeit of stimulated whole saliva on periodontal conditions. In this elderly population there was no significant relationship between SFR and periodontal conditions, while a significantly higher mean AL was found in those subjects with SS > 2.00 mm. In addition, a stronger relationship was found when evaluating both SFR and SS than evaluating SS alone, and the significant relationship persisted

Table 4 – The mean values on periodontal parameters by salivary spinnbarkeit (SS)

Periodontal parameters	SS ≤ 2.00 (n = 275)	SS > 2.00 (n = 80)
Mean PD (mm)	2.1 ± 0.5	2.2 ± 0.5 NS
% sites with PD ≥ 4 mm	9.6 ± 10.9	12.4 ± 13.6 NS
% sites with PD ≥ 6 mm	1.5 ± 3.5	1.6 ± 4.4 NS
Mean AL (mm)	3.2 ± 1.0	3.5 ± 1.1*
% sites with AL ≥ 4 mm	35.5 ± 28.0	41.6 ± 28.2 NS
% site s with AL ≥6 mm	7.4 ± 12.8	9.0 ± 15.3 NS
% sites with BOP	11.3 ± 12.5	14.0 ± 14.7 NS

Mean values ± S.D. are given. NS: not significant. P values were obtained from Student t-test.
* $p < 0.05$.

after controlling for other confounding factors. These findings suggest that the low SFR alone is not related to the periodontal conditions, and that both high SS and low SFR would be a potential risk for periodontal disease. In other words, little and sticky stimulated saliva would adversely affect on periodontal tissues. It seems that the current of such little and sticky saliva in the oral cavity would be obstructed. Thus, it is possible that cleansing ability, one of the most important roles of saliva, would not work well and that the plaque accumulation would be encouraged. However, it is not evident that which salivary constituent would be related to and how much saliva would be enough for maintaining oral and periodontal health, so further study is required for clarifying this issue.

In this study population, the mean SFR was 1.62 ± 0.93 and 1.23 ± 0.65 ml/min in males and females, respectively. Currently, there is no general agreement on a flow rate value that distinguishes between normal and abnormal.[26,27] On a population basis, it was shown that the mean SFR was, respectively, 1.34 and 0.98 ml/min in 75-year-men and women in an elderly sample representative of a total population.[28] Also, it was exhibited that the mean SFR was, respectively, 1.68 and 1.30 ml/min in 76-year-men and women in an elderly population living at home.[2] Thus, elderly people in this study had a similar SFR as the other elderly populations.

The difference in stimulated salivary flow rates between genders has been reported previously.[2,29–31] The result of our investigation revealed higher flow rates for men compared with women. This finding might have been caused by differences in degree of hydration or size of the salivary glands.[32,33] Moreover, salivary flow rates have been reported to decrease after post-menopausal age in women.[34]

In this study population, male gender had a strong negative influence on periodontal conditions, despite the fact that men have significantly higher salivary flow as compared to women. It was reported that stimulated salivary flow rates were significantly lower in women than in men, while root caries

Table 6 – Multivariate logistic regression analysis to explore factors for subjects PD ≥ 4 mm in the highest 20th percentile

Independent variables	Odds ratio	P	95% CI
Subjects with			
SFR ≥ 0.7 and SS ≤ 2.00 (ref.)	1.00		
SFR < 0.7 and SS ≤ 2.00	1.74	0.197	0.75–4.01
SFR ≥ 0.7 and SS > 2.00	1.56	0.263	0.72–3.37
SFR < 0.7 and SS > 2.00	3.84	0.028	1.15–1277
Gender (0: female, 1: male)	0.88	0.811	0.31–2.50
Number of teeth present			
1–9	1.37	0.426	0.63–2.94
10–19	1.16	0.701	0.55–2.42
20–32 (ref)	1.00		
Smoking; status			
Current	5.08	0.007	1.57–16.44
Former	2.16	0.155	0.75–6.26
Never (ref)	1.00		
Number of medications			
0 (ref.)	1.00		
1–4	0.84	0.641	0.40–1.75
5≤	0.60	0.278	0.24–1.51
Number of diseases			
0 (ref.)	1.00		
1–2	1.70	0.215	0.74–3.92
3–5	0.48	0.403	0.09–2.68
Interdental cleaning (0: daily/frequently; 1: rarely/never)	2.12	0.028	1.08–4.16
Last dental visit (0: within 1 year; 1: more than 1 year)	1.16	0.661	0.59–2.28
% sites with BOP (0: ≤19.4%; 1: >19.4%)	5.20	0.000	2.58–10.46

Dependent variable: subjects with PD ≥ 4 mm in the highest 20th percentile. N = 350; $p < 0.001$; pseudo R^2 = 0.19.

Table 5 – The mean values on periodontal parameters by salivary flow rate (SFR) and salivary spinnbarkeit (SS)

Periodontal parameters	SS ≤ 2.00		SS > 2.00	
	SFR < 0.7 (n = 56)	SFR ≥ 0.7 (n = 219)	SFR < 0.7 (n = 17)	SFR ≥ 0.7 (n = 63)
Mean PD (mm)	2.2 ± 0.5	2.1 ± 0.5	2.5 ± 0.6	2.2 ± 0.5*
% sites with PD ≥ 4 mm	10.6 ± 11.3	9.3 ± 10.8	18.7 ± 18.3	10.6 ± 11.6*
% sites with PD ≥ 6 mm	1.5 ± 3.2	1.5 ± 3.5	3.7 ± 8.1	1.1 ± 2.4 NS
Mean AL (mm)	3.1 ± 0.8	3.3 ± 1.0	4.2 ± 1.7	3.3 ± 0.8**
% sites with AL ≥ 4 mm	31.3 ± 24.6	36.6 ± 28.7	54.3 ± 31.3	38.2 ± 26.5*
% sites with AL ≥ 6 mm	5.4 ± 7.6	7.9 ± 13.8	19.8 ± 26.4	6.1 ± 8.7**
% sites with BOP	10.5 ± 9.6	11.5 ± 13.1	17.5 ± 15.3	13.1 ± 14.5 NS

Mean values ± SD are given. NS: not significant. P values were obtained from one-way analysis of variances.
* $p < 0.05$.
** $p < 0.01$.